METHOD AND APPARATUS FOR DYNAMICALLY DETERMINING WHEN TO USE QUALITY OF SERVICE RESERVATION IN INTERNET MEDIA APPLICATIONS

BACKGROUND

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Resource reservation and call admission control are important facilities to provide in any Internet Protocol (IP) telephony, video conferencing, or Internet multimedia application. Without such facilities, the applications can fail in the presence of Quality of Service (QoS) problems.

10   The solution to these problems usually involves explicit reservation/admission control signaling by endpoints of the media sessions, through a signaling protocol like Resource Reservation Protocol (RSVP) or the emerging Next Steps In Signaling (NSIS) protocol.

Unfortunately, not all endpoints support these protocols. In order to ameliorate the crippling effects of not having bandwidth reservation or admission control in these cases,

15   Media Transfer Points (MTPs) and admission control proxies have been developed which act on behalf of endpoints lacking the necessary QoS signaling protocols.

These band-aids help, but have a number of disadvantages, chief among them being decreased robustness because there is now a stateful intermediary in the media path between the endpoints. Another disadvantage is higher resource usage because the media traffic no

20   longer flows on the optimal path between the endpoints, and because extra processing is needed to perform the media transfer point functions. In addition, the MTP can easily become a "hot spot" and create QoS problems where they would otherwise not exist.

The present invention addresses this and other problems associated with the prior art.

SUMMARY OF THE INVENTION

A call controller is configured to monitor call signaling for a media call between a first and second endpoint. The call controller dynamically determines when to insert a media proxy into a media path for the call according to a relationship in network topology between the first and second endpoint.

The foregoing and other objects, features and advantages of the invention will become more readily apparent from the following detailed description of a preferred embodiment of the invention which proceeds with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a network that dynamically determines when to insert a media proxy in a media session.

FIG. 2 is a flow diagram describing in more detail how a call controller determines when to insert the media proxy.

FIG. 3 is a diagram showing one example of how to identify endpoints on a same subnet.

FIG. 4 is a diagram showing another example of how to identify endpoints on a same subnet.

FIG. 5 is a diagram showing another embodiment of the call controller that inserts a media proxy into a media session according to a routing metric value.

FIG. 6 is a flow diagram showing functions performed by the call controller in FIG. 5.

DETAILED DESCRIPTION

The need for a QoS intermediary device is dynamically determined based on the network topology relationship between call endpoints. The intermediary device is inserted in the media session to request proper admission control and Quality of Service (QoS) behavior on behalf of the endpoint. No intermediary device is inserted when the network topology relationship between the endpoints indicates that proper admission control or QoS can be achieved without reservation through the intermediary device.

Referring to FIG. 1, a Wide Area Network (WAN) includes endpoints 12 and 14 coupled through a subnet 18 to the rest of an Internet Protocol (IP) network 28. Another subnet 38 connects another endpoint 42 at some other location in the IP network 28.

The endpoints 12, 14, and 42 can be any device used for sending or receiving a media stream. For example, the endpoints can include a Voice Over IP (VoIP) phone, a conventional analog phone coupled to the network via a gateway (not shown), a computer, an audio or video server, or any other device that may need to either send or receive audio, video or any other type of media stream.

The subnets 18 and 38 in one embodiment refer to a portion of a network that shares a common address component. However, the subnets 18 and 38 can also refer to a same Local Area Network (LAN), endpoints within some common geographical area, a common set of endpoints that are serviced by a common network device, or any other network topology relationship that may affect QoS.

One of the endpoints, such as endpoint 12, may direct a call to endpoint 42 located at another location in Internet 28. Since the media path 34 between endpoint 12 and endpoint 42 has to travel over the IP network 28, it may be necessary to provide a QoS reservation for

the media session. However, the endpoint 12 or the endpoint 42, or both, may not support a QoS reservation protocol, such as RSVP.

A call controller 24 monitors the call signaling 22 used by the endpoints 12, 14, and 42 for establishing the media session. For example, the call signaling may include SIP,

5   H.323, H.225, H.245, or any other signaling used for establishing a media stream between two or more endpoints.

The call controller 24 identifies endpoints that do not support a Quality of Service (QoS) reservation protocol and uses a media proxy 26 to conduct the QoS reservation on behalf of the endpoint. The media proxy 26 can be any media transfer point, Real Time

10   Transport Protocol (RTP) mixer/translator, Resource Reservation Setup Protocol (RSVP) proxy, media gateway, or any network processing device used for reserving network resources.

The media proxy 26 and the call controller 24 are shown as separate network processing devices for explanation purposes, but could alternatively be in the same network

15   processing device or could be incorporated in other switches, routers, gateways, etc. in the network.

The media proxy 26 in one situation may conduct the QoS reservation 32 directly with a destination endpoint, such as endpoint 42. Otherwise, the media proxy 26 may conduct the QoS reservation 32 with another media proxy 36 that conducts the QoS

20   reservation on behalf of endpoint 42. After the QoS reservation 32 is established, the two endpoints start sending media over media path 34.

Using a media proxy on behalf of an endpoint to reserve network resources is described in co-pending applications Ser. No. 09/415,952 entitled METHOD AND APPARATUS FOR GENERATING AN RSVP MESSAGE FOR A NON-RSVP-ENABLED

NETWORK DEVICE filed October 8, 1999 and Ser. No. 09/940,753 entitled RSVP

TRANSMITTER PROXY filed August 28, 2001 which are herein incorporated by reference.

In another example, the endpoint 12 may make a call to another endpoint 14 in a same

general geographical or network vicinity. For example, endpoints 12 and 14 may be located

5   in the same building, or if not located in the same building, may be connected to the same

subnet, router, switch, gateway, etc.

In this situation, it may not be necessary to conduct QoS reservation prior to

establishing the media session between endpoints 12 and 14. Since the two endpoints 12 and

14 are connected through one or a few network processing devices, it is less likely that

10   bandwidth problems will occur.

Dynamic Media Proxy Insertion

The call controller 24 dynamically determines whether or not to insert the media

proxy 26 in the media session according to the network topology relationship between the

15   media session endpoints. Referring to FIGS. 1 and 2, the call controller 24 monitors

signaling 22 for the source endpoint in block 50 and determines a relative network topology

between the source endpoint and the destination endpoint in block 54.

The call controller 24 determines whether the two endpoints are within the same

network topology range in decision block 56. If the two endpoints are not within the same

20   range, the call controller 24 inserts the media proxy 26 into the call path in block 60. The

media proxy 26 then conducts a QoS reservation on behalf of the endpoints to ensure

satisfactory call transport over the media path 34.

If the destination endpoint, such as endpoint 42, supports the QoS reservation protocol

32, then the media proxy 26 may conduct the QoS reservation directly with endpoint 42.

Alternatively, the media proxy 26 may conduct the QoS reservation with another media proxy 36 that operates on behalf of the destination endpoint 42. A media stream for the call 20 between the two endpoints is then passed through the media path 34 established through the media proxy 26.

5   If the two endpoints are within the same network range in block 56, the call controller 24 does not insert the media proxy 26 into the media session in block 58. Since the two endpoints have a relatively close network proximity, it is likely that a satisfactory media exchange can be conducted without first having to use the media proxy for a QoS reservation. The two endpoints, for example, endpoints 12 and 14, then conduct the media session 16

10   without going through media proxy 26.

The example above refers to a media call between a source endpoint and a destination endpoint. But it should be understood that the dynamic media proxy insertion can also be used for calls between more than two endpoints. For example, a conference call may be initiated between more than two endpoints. If the call controller determines two or more of

15   the multiple endpoints in the conference call are outside of the same network topology range, a media proxy is inserted between the endpoints. If all of the endpoints are within the same network range, then no media proxy is used.

Subnets

20   FIG. 3 shows one example of how the call controller 24 determines whether or not the two endpoints for the media session are within the same network topology range. In this example, the call controller 24 monitors call signaling 22 from the endpoint 12 over IP network 71. The call signaling can use any IP based call signaling protocol including Session Initiation Protocol (SIP), skinny client control protocol (SCCP), H.323, H.225/H.245, etc.

The call signaling 22 includes the IP addresses 62 for the source endpoint 12 and the destination endpoint. The call signaling may not come directly from the endpoint 12, but could alternatively come through a gateway or call manager that converts telephone numbers into the IP addresses 62. In the embodiment shown in figure 3, the call signaling 22 also

5   includes a subnet mask 64. The subnet mask is known to those skilled in the art and is typically used to determine what subnet an IP address belongs to.

The call controller 24 applies both the source and destination IP addresses 62 to the subnet mask 64. If the significant bits of the two IP addresses match after being applied to the subnet mask, the two endpoints are determined to be within a same subnet. In this

10   situation, no media proxy 26 is inserted into a call path 73. If the two addresses 62 are not within the same subnet, then the media proxy is inserted into a call path 73.

The subnet mask comparison is described below in further detail. An IP address has two components, the network address and the host address. For example, consider the IP address 150.215.017.009. Assuming this is part of a Class B network, the first two numbers

15   (150.215) represent a Class B network address, and the second two numbers (017.009) identify a particular host on the network. If this network is divided into 14 subnets, however, then the first 4 bits of the host address (0001) are reserved for identifying the subnet.

The subnet mask is the network address plus the bits reserved for identifying the subnetwork. In this case, therefore, the subnet mask would be

20   11111111.11111111.11110000.00000000. The subnet mask is used to identify the subnet to which an IP address belongs by performing a bitwise AND operation on the mask and the IP address. The result is the subnetwork address:

Subnet Mask   255.255.240.000   11111111.11111111.11110000.00000000

IP Address   150.215.017.009   10010110.11010111.00010001.00001001

Subnet Address   150.215.016.000   10010110.11010111.00010000.00000000

The subnet address for IP address 150.215.017.009 is therefore 150.215.016.000. If

the IP addresses 62 for the two endpoints have the same subnet address, then the media proxy

26 is not inserted into the call path 73 between the two endpoints.

FIG. 4 shows an alternative embodiment where the call controller 24 queries a

5   Dynamic Host Configuration Protocol (DHCP) server 66 for the subnet mask 64. The

DHCP/DHCPv6 server 66 assigns dynamic IP addresses to devices on IP network 71. The

DHCP server 66 can be any network processing device that provides the subnet mask 64.

The call controller 24 makes a subnet mask request 68 to the DHCP server 66. The

call controller 24 can make the subnet mask request 68 periodically or can make the subnet

10   mask request pursuant to receiving call signaling 70 from the endpoint 12.

The call controller 24 applies the subnet mask 64 to the IP addresses received in the

call signaling 70 in the same manner described above in FIG. 3. If the two IP addresses have

the same subnet address, the call controller 24 does not insert the media proxy 26 into the call

path 73. If the two endpoint addresses do not have the same subnet address, the media proxy

15   26 is inserted into the call path 73 between the two endpoints.

There are several ways that the call controller 24 can identify the DHCP server 66 for

requesting the subnet mask 64. One way to identify the DHCP server 66 is to take the IP

address for the endpoint and feed it into a reverse DNS lookup map. The name of the DHCP

server responsible for the subnet containing the endpoint IP address is input into the reverse

20   DNS lookup map. A DNS lookup provides the IP address for the DHCP server. A query is

than made to the DHCP IP address requesting the subnet mask 64.

Multiple Subnet Range

It may be determined that a media proxy is not required when the two endpoints are within a certain group of subnets. Even though the two endpoints are not on the same subnet, the network topology may be such that QoS reservation is not necessary within a particular

5   group of subnet addresses.

The call controller 24 can modify the bits in the received subnet mask 64 to increase the range of IP addresses that will generate a same subnet address. Alternatively, the call controller 24 can compare the subnet addresses for the source and destination endpoints. No media proxy is inserted for any subnet addresses within a predetermined subnet address

10   range. A media proxy is used for subnet addresses outside of the subnet address range.

Routing Metrics

FIG. 5 shows another embodiment where the call controller 24 uses a routing metric to determine when to insert the media proxy 26 into call path 73. The call controller 24

15   includes a processor 81 that operates a routing protocol in passive or "quiet" mode 74 that passively listens for routing messages 80 sent over the IP network 71. The passive instance of routing protocol 74 uses the routing messages 80 to update a routing map 72. The endpoint IP addresses 76 and 78 are applied to the routing map 72 to generate a metric value 76. The metric value 76 is then used to dynamically determine when to insert the media

20   proxy 26 into the path 73.

Typically, a routing protocol uses metric values generated from a routing map to compute an optimal path consisting of a sequence of links over which packets are forwarded. However, the call controller 24 provides the novel operation of using the metric value 76 to determine when to insert media proxy 26 into call path 73. The routing protocols used in the

passive routing protocol instance 74 can include any existing link state routing protocol such as Open Shortest Path First (OSPF) or Intermediate System to Intermediate System (IS-IS). Since these routing protocols are known to those skilled in the art, they are not explained in further detail.

5   Referring both to FIGS. 5 and 6, the routing protocol 74 is a conventional link state routing protocol operating in block 94 in a passive or "quiet" mode. Operating in a quiet mode means the routing protocol 74 listens passively to routing messages 80 and updates the conventional routing map 72 in block 96 as if it were actually going to route packets. The routing map 72 shows every node and every link in an associated area of IP network 71. A

10   metric value is associated with every link identified in the routing map 72.

In block 82 the call controller receives call signaling from endpoint 12. The call signaling 79 includes a source IP address 76 and a destination IP address 78. The destination endpoint IP address 76 is fed into the routing map 72 in block 84. The call controller 24 in block 86 treats the source endpoint IP address 76 as its own local IP address when applying

15   the destination IP address 76 to the routing map 72. The call controller 24 then determines the shortest path to the destination IP address 78.

The shortest path is not really needed. But a total metric value 76 for all the links in the shortest path to the destination IP address 78 is generated during the shortest path computation in block 88. This generated metric value 76 is compared with a policy value 77

20   in block 90. The policy value 77 is a predetermined empirically generated value stored in the call controller 24 that defines a threshold for either inserting or not inserting the media proxy 26.

If the metric value 76 generated by the routing map 72 is above the policy value 77, the media proxy 26 is inserted into the call path 73 in block 98. If the metric value is below

the policy value 77, the media proxy is not inserted into the call path in block 92. This has the desired effect because the metric threshold conventionally represents an upper bound of the cost of the path between the two endpoints above which QoS treatment is necessary in order to provide acceptable performance.

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Endpoints Supporting QoS Reservation Protocols

In the embodiments described above one or more of the endpoints do not support a QoS reservation protocol. Therefore, the media proxy 26 is selectively inserted into the call path to conduct the QoS reservation on behalf of the endpoint. In another embodiment,

10   endpoint topology is analyzed for endpoints that support QoS reservation protocols.

The call controller, or the endpoints themselves, can conduct the network topology analysis between the source and destination endpoints as described above. However, the endpoints already support a QoS reservation protocol. Therefore, the results of the topology analysis do not determine whether or not a media proxy is inserted into the call path.

15   Alternatively, the results of the network topology analysis dynamically determines whether or not the endpoints themselves will conduct the QoS reservation. This eliminates unnecessary reservation signaling between endpoints that support QoS reservation protocols.

The invention described above avoids the robustness problems of a stateful intermediary in cases where it is not necessary. Dynamic media proxy assignment also

20   avoids the resource usage, performance, and possible QoS problems of a media transfer point in cases where it is not necessary.

The system described above can use dedicated processor systems, micro controllers, programmable logic devices, or microprocessors that perform some or all of the operations.

Some of the operations described above may be implemented in software and other operations may be implemented in hardware.

For the sake of convenience, the operations are described as various interconnected functional blocks or distinct software modules. This is not necessary, however, and there may be cases where these functional blocks or modules are equivalently aggregated into a single logic device, program or operation with unclear boundaries. In any event, the functional blocks and software modules or features of the flexible interface can be implemented by themselves, or in combination with other operations in either hardware or software.

Having described and illustrated the principles of the invention in a preferred embodiments thereof, it should be apparent that the invention may be modified in arrangement and detail without departing from such principles. I claim all modifications and variation coming within the spirit and scope of the following claims.

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